FY03 Technical Program Summary

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Vehicle Technology Directorate - Langley Site
US Army Research Laboratory
at
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Hampton, VA 23681-0001

The ARL Vehicle Technology Directorate at the Langley Research Center conducts research in two business areas:

Structural Mechanics and
Loads & Dynamics

Program areas funded under these technical competencies include basic (6.1) and applied (6.2) research in Aviation Technology and Ground Vehicle Technology. The following "Table of Contents" outlines the organization of the work packages and individual research projects within this document.

Aviation Loads & Dynamics Research - 6.1 - 61102 / AH66 / VS1015

VS1015.AA01	Fundamental Studies of Elastically Coupled Structures
VS1015.AL05	Analytical Aeroelastic Modeling of Advanced Rotor Configurations
VS1015.AL06	High Performance Piezoelectric Actuator Development
VS1015.AL07	Lightweight Multifunctional Structural Components Development
VS1015.AR01	Structural and Material Characteristics of Biological Morphologies
VS1015.DC01	Crashworthiness of Composite Frames and Floor Sections

Ground Vehicle Loads & Dynamics Research - 6.1 - 61102 / AH42 / VS1016

VS1016.DC02	Nonlinear Mechanics of Elastomeric and Composite Structures

Aviation Structural Mechanics Technology - 6.2 - 62211 / A47B / VS2011

VS2011.CA01	Probabilistic and Non-Deterministic Methods for Structural Design
VS2011.CA02	SARAP Crash Safety Research Program
VS2011.CD01	Research on Advanced Aircraft Structural Concepts
VS2011.IC01	SARAP Low-Velocity Impact Damage Tolerance of Sandwich Composites
VS2011.IC02	Skin/Stiffener Debonding Analysis Methods
VS2011.IC03	Exploratory Research on Adaptive Sensors for Composite Rotorcraft
VS2011.IF04	Z-pin Reinforcement Analysis
VS2011.IF08	Fatigue Life Methodology of Metallic Rotorcraft Dynamic Components
VS2011.IF11	Impact Damage Resistance & Tolerance of Thin Skin Composite Sandwich Structure
VS2011.IF12	Reliability-Based Design Methods
VS2011.IN01	Composite Thermal Nondestructive Evaluation
VS2011.IN07	SARAP NDE/Reparability Program

Ground Vehicle Structural Mechanics Technology - 6.2 - 62105 / AH84 / VS2012

VS2012.CA01	Research on Ground Combat Vehicles
VS2012.CA02	Buckling - Vibration Interaction
VS2012.CD01	Selective Reinforcement of Aluminum Structures
VS2012.CD02	Multi-Functional Structures
VS2012.IN07	NDE of Composite Structures Using Laser Ultrasonics
VS2012.IN12	NDE of Electrical Wire Insulation Using Ultrasonics

Aviation Loads & Dynamics Technology - 6.2 - 62211 / A47B / VS2015

VS2015.AA02	High-Speed Aeroelastic Research Models
VS2015.AA04	ARES Enhancements/Projection Moire Interferometry
VS2015.AE02	Regenerative Electronics
VS2015.AL04	Experimental Investigation of Active Twist Rotor Concepts for Vibratory Load Reductio
VS2015.AL05	Analysis and Design of Active Twist Rotor Blades
VS2015.DA02	Adaptive Structural Morphing Kinematics
VS2015.DC08	Innovative Composite Fuselage Design for Improved Crashworthiness
VS2015.DC09	Soft Soil - Water Impact
VS2015.DC10	Crash Resistant Fuel Systems (CRFS)
VS2015.DC11	Crash Simulation of an ATR42 Aircraft
VS2015.DC12	Fokker F-28 Crash Test Support
VS2015.DT01	Applications of Structural Tailoring Concepts

Ground Vehicle Loads & Dynamics Technology - 6.2 - 62105 / AH84 / VS2016

VS2016.DR08	Ground Vehicle Mobility
VS2016.DR10	Inflatable Structures
VS2016.DR14	Modeling of Thin Membrane Structures

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BUSINESS SUBAREA: 6.2 STRUCTURAL MECHANICS

PE/PRJ/WP#/WP: 62211 A47B VS2011 Aviation Structural Mechanics Technology

DIRECTORATE/DIVISION ARL Vehicle Technology Directorate Structural Mechanics

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THRUST:

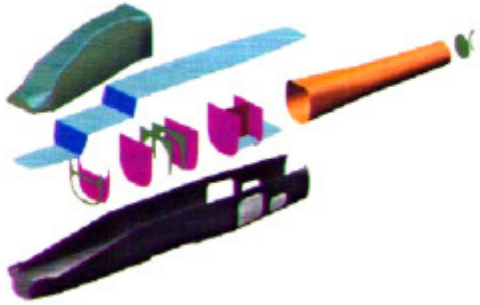
Applied and exploratory structural mechanics research to develop and validate damage tolerance, fatigue durability, nondestructive inspection, and advanced structural analysis design methods for metallic and composite rotorcraft dynamic components and airframe structures.

New concepts and advanced structural analysis methods for composite/hybrid structures that provide design tools for lighter, safer, more reliable and more affordable manned and unmanned Army rotorcraft.

OBJECTIVES:

* Apply advanced structural analysis methods to composite/hybrid structures and validate design tools for accurate loads and stress analysis.
* Incorporate composite delamination failure criteria for strength and fatigue predictions to extend static/fatigue limits of flight critical dyn components.
* Apply advanced NDE methods for field inspection of composite/hybrid structures to reduce MLH/FH and manufacturing costs.
* Test and validate advanced design methods to reduce EW/GW ratio and to increase structural efficiency.

Light Weight and Affordable Rotorcraft Structures



PROGRAM SCHEDULE:

RESEARCH STUDIES	2002	2003	2004	2005	2006
Probabilistic and Non-Deterministic Methods for Structu	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
SARAP Crash Safety Research Program	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Research on Advanced Aircraft Structural Concepts	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	
SARAP Low-Velocity Impact Damage Tolerance of Sandv	▪▪▪▪	▪▪▪▪	▪▪▪▪		
Skin/Stiffener Debonding Analysis Methods	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Exploratory Research on Adaptive Sensors for Compos		▪▪▪▪	▪▪▪▪	▪▪▪▪	
Z-pin Reinforcement Analysis	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Fatigue Life Methodology of Metallic Rotorcraft Dynamic	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Impact Damage Resistance & Tolerance of Thin Skin Co	▪▪▪▪	▪▪▪▪	▪▪▪▪		
Reliability-Based Design Methods		▪▪▪▪	▪▪▪▪	▪▪▪▪	
Composite Thermal Nondestructive Evaluation	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
SARAP NDE/Reparability Program	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪

FY03 KEY DELIVERABLES:

* Probabilistic methods for multi-disciplinary design problems to include aerodynamic-structure-thermal interactions.
* Advanced finite element models for crash simulation in support of SARAP STO.
* Validated failure mechanisms in impact-damaged specimens through destructive evaluation.
* Analysis method for disbonds at skin/stringer interface in composite panels.
* Methods for characterizing actuator-to-composite bond fracture toughness and fatigue life.
* Test specimens to characterize flexible composite components with embedded actuators.
* FE analysis of SARAP structural component to define statistical characteristics of critical design parameters.
* New thermal heating techniques to remove background infrared noise.
* Portable inspection technologies for field damage assessment and repair quality assurance.

This chart covers Fiscal Year 2003

Business SUBAREA:	6.2		STRUCTURAL MECHANICS	
PE/PRJ/WP#/WP:	62211	A47B	VS2011	Aviation Structural Mechanics Technology

Workyears	2002	2003	2004	2005	2006
ARMY	5.15	5.5	5.8	4.6	3.1
NASA	2.5	2.6	2.6	.2	.2
OTHER	1.3	4.05	4.15	3.65	2.65

STRUCTURAL MECHANICS

OBJECTIVE

Support the AMCOM Survivable, Affordable Reparable Airframe Program (SARAP) STO by working directly with the rotorcraft companies in durability and damage tolerance, crashworthiness, and NDE. In addition, this Workpackage supports Rotary Wing Vehicle (RWV) structures technical objectives. The rsults of this ARL applied research will demonstrate that composite structures can meet the low weight, low cost, and high performance requirements for future manned and unmanned Army rotorcraft.

To develop and validate structural integrity technologies for metallic and composite structures. The current focus is on the development of design criteria for life extension methodologies and reliable inspection methods for field applications.

APPROACH

Applied research is being conducted through in-house and cooperative efforts that leverage NASA facilities and technology programs. This research validates strength and damage tolerance design tools for tailored composite structures as well as develops innovative nondestructive evaluation methods for composites bond integrity. Other Army activities support and leverage international collaborative programs such as The Technical Cooperation Program (TTCP). The research in metallic fatigue durability includes reliability analysis, multi-sight damage evaluation, and load interaction effects for fatigue life predictions. In addition to life extension assessments for rotorcraft dynamic components is the application of advanced NDE methods to inspect for damage and flaws in composite structures. A significant portion of this research is conducted jointly with the US helicopter industry through Cooperative Research and Development Agreements (CRDAs). This work is also jointly worked through on-going projects funded by the National Rotorcraft Technology Center (NRTC).

SIGNIFICANCE

The benefits to Army aviation will be validated design tools along with reliable and quantitative inspection methods for aviation metallic and composite structures. Payoffs will also included needed life extension technology for the current fleet as well as reliability and durability enhancements for future Army rotorcraft. The results of this joint ARL/NASA support will help to ensure the ability of US defense contractors to build lightweight, reliable, durable, and low-cost rotorcraft structures essential to the Army Objective Force and future vehicles like the FCS and FTR. More importantly, this technology will provide the Army with needed maintenance and inspection procedures for operating and supporting the fleet. The technical accomplishments of this Workpackage directly support RWV goals and payoffs.